Chapter 3
Operating and Maintenance Procedures

Section I
Operating Vehicle Engines in Cold Weather

Once vehicles are started and operations begin, operators must remain aware of the special problems cold weather can cause. This chapter provides added guidance to consider when performing vehicle/equipment during-and after-operations PMCS.

OPERATING AND IDLING

At temperatures below -20°F, operators may have to start vehicle engines periodically to maintain an acceptable state of readiness. However, this should not be done if other means are available, such as power plant heaters, external heat, or indoor parking.

Before commanders authorize periodic starting of engines, they must consider fuel supplies. Also, they must establish starting and shutdown schedules to ensure engines do not run continuously. At temperatures below -25°F, it may require a continuous idle of engines, especially heavy equipment, tracked vehicles, and heavy trucks. Idle speeds, as specified in the appropriate TM, must be followed.

Experience determines starting and shutdown intervals. Factors such as ambient or expected temperatures, vehicle condition, and readiness conditions influence scheduling. The following must also be considered--

- Vehicles should only be cold-started using the procedures outlined in the TM. Carefully read and follow the instructions for operating the vehicle under unusual conditions (cold). This is particularly important for operating the engine starter and induction manifold. Most equipment publications contain cautions relative to the time of engine starter engagement. However, it is sometimes necessary to exceed the recommended starter time. This is due to the cold-starting characteristics of most internal combustion engines. If a starter time limit is 30 seconds, and engine firing is intermittent during cranking, it may be wise to briefly extend the starter engagement time.

- Vehicles should not be allowed to become cold-soaked.

- Engines should be started periodically to keep lubricants warm.

- Batteries must be kept warm and fully charged.

- Depending on the situation, concealment and noise discipline may have to be sacrificed to maintain readiness of the vehicles.

Idling Limitations

Vehicle engine idling is wasteful and may be hazardous. It has detrimental effects on fuel supply, tactical missions, and safety for the following reasons:

- Increases fuel consumption.

- Discharges batteries.

- Causes engine wear and reduces engine overhaul periods.

- Causes spark plug fouling especially in two stroke cycle engines such as all terrain vehicles, snowmobiles, outboard motors, etc.

- Causes possible carbon monoxide hazards.

- Endangers concealment and camouflage.

- Potentially causes engine overheating.

- Potentially causes slobber of diesel engines. To reduce slobber of diesel engines, which is unburned diesel fuel and exhaust that builds up around the exhaust pipe in cold weather during idling, increase the idle speed. Otherwise, this condition should clear up after a short period of normal operation at normal operating temperatures.

Vehicle engines, except diesels, must not idle for excessive periods (never longer than five minutes) while vehicles are awaiting, discharging, or receiving passengers. Vehicle engines must not idle to operate personnel heaters. Vehicles with diesel engines may have to be idled to eliminate starting difficulties. Efficient vehicle and power plant heater maintenance eliminates starting problems.

NOTE: When it is anticipated that vehicles equipped with diesel engines will be in a static position for 30 minutes or less, operate engines at the prescribed idling speed.

NOTE: When temperatures are below -25°F, it may be necessary to operate diesel engines continuously to ensure operational responsiveness.

Operator Requirements

A licensed operator must be present in the driver's compartment whenever the main and/or auxiliary engine is being operated.

Engine oil and coolant levels must be checked daily prior to initial starting of engine. Battery electrolyte fill levels must be checked daily. When engine operation is required for battery recharging or engine warm-up, an engine speed of 1,000 to 1,200 RPM, as prescribed in the vehicle TM, must be maintained. Occasional variance of speed for short periods is authorized.

WARNING

OPERATION OF THE MAIN ENGINE OR AUXILIARY GENERATOR ENGINE WHEN A VEHICLE IS STATIONARY EXPOSES THE CREW TO POSSIBLE CARBON MONOXIDE GAS POISONING. THE POSSIBILITY IS GREATLY INCREASED WHEN HATCH DOORS ARE CLOSED. TO MINIMIZE THIS HAZARD, POSITION VEHICLE WHEREVER POSSIBLE SO THAT WIND WILL CARRY FUMES AWAY FROM CREW COMPARTMENT; THEN TURN ON TURRET VENTILATION BLOWER. BE SURE ENGINE COMPARTMENT BULKHEAD DOORS ARE SECURED BEFORE OPERATING ENGINES. WHEN THERE IS NO OUTSIDE AIR MOVEMENT, PERSONNEL MUST DISMOUNT FOR AT LEAST 10 MINUTES EACH HOUR (TACTICAL SITUATION PERMITTING).

Engines Equipped with Power Plant Heaters

Vehicles equipped with liquid-cooled engines are provided with power plant heaters. These must be used for standby heat or engine preheating when outside ambient temperatures are below -20°F. The power plant heaters must be properly maintained year round. Some power plant heaters must not be operated when vehicle engine is operating; check the TM before operation.

Engines not Equipped with Power Plant Heaters

When temperatures fall below -20°F, vehicles not equipped with power plant heaters must be operated at 1,000 to 1,200 RPM to ensure equipment is ready. Intervals between engine operations depend upon wind speed and temperature. Operate engines a minimum of 20 minutes every 2 1/2 hours.

Vehicles Equipped with Radios

When radios in radio-equipped vehicles are in use, keep the engine operating at approximately 1,200 RPM. This maintains a satisfactory battery charge. If this procedure is not followed, batteries will fail rapidly.

When starting radio-equipped vehicles, operators must protect the radios. Ensure that the power amplifier switch is in the OFF position, or that the radio function switch is in the OFF or STANDBY position when starting (Figure 3-1).

STARTING WITHOUT ASSISTANCE

Starting a vehicle in severe cold can present a number of challenges. Ensure proper procedures are followed to safeguard personnel and equipment.

Gasoline Engines

In cold weather, storage batteries become less efficient and provide much less output. A cold battery cannot energize the starter to turn over the engine at the required cranking speed and also supply the current needed to ignite the spark plugs. The fuel is often not volatile enough to supply proper fuel-air mixture to the combustion chamber.

For a successful start in cold weather, ensure the following conditions exist:

- The viscosity of the engine lubricating oil permits cranking without overtaxing the capacity of the starting system. The engine oil must splash and be distributed easily by the oil pump to the various parts and bearings.

- The battery is fully charged and warm enough to supply current to crank the engine and the spark needed for ignition.

- The ignition primary and secondary circuits are clean and free of cracks, frost, and moisture to prevent shorts or current leaks.

- The distributor breaker points are free of oxidation and moisture, in good condition, correctly adjusted, and checked frequently.

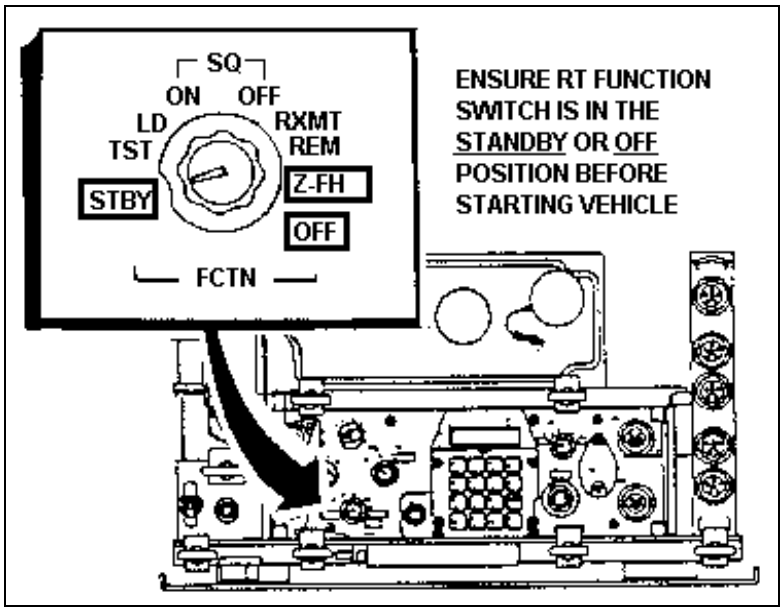


Figure 3-1. Protect radios when starting vehicles

- Ether is used as an emergency starting aid only if a slave kit and/or portable heater are unavailable for preheating. Exercise extreme caution and use ether only as a last resort to prevent mission failure. Consult appropriate -10 series manual when using emergency starting aids.

CAUTION
ETHER SHOULD BE INJECTED INTO ENGINE AIR INTAKE SYSTEM ONLY WHILE THE ENGINE IS BEING TURNED OVER. OTHERWISE, FLASHBACK MAY OCCUR.

Diesel Engines

Diesel engines are particularly difficult to start in cold weather without preheating the intake air. Since the air is heated by compression, it must attain a temperature hot enough to ignite the injected fuel. This preheating can be accomplished as follows:

- Use air manifold heaters when the ambient temperature drops below +32°F. Employ this device only when the engine is turned over. Switch off the air manifold heater when the engine starts.

- Warm the engine with external heat to preheat the engine.

- If so equipped, operate the engine coolant fuel-fired preheater for the prescribed amount of time before starting.

USING AUXILIARY POWER (SLAVE) RECEPTACLE

The auxiliary power (slave) receptacle is used to start a vehicle when its batteries are unable to supply starting current.

The procedures that follow generally apply to tactical vehicles, combat vehicles, and self-propelled weapons. Refer to the vehicle operator's manual for instructions and procedures.

- Start the engine of the vehicle supplying the auxiliary power; adjust the engine idling speed to 1,200 RPM.

- Connect the slave cable to the auxiliary power receptacle in each vehicle.

CAUTION
ENSURE THAT SLAVE CABLE IS CONNECTED POSITIVE TO POSITIVE AND NEGATIVE TO NEGATIVE. BATTERIES ARE CHECKED PRIOR TO SLAVE STARTING. IF THE DEAD VEHICLE HAS A MASTER SWITCH, IT MUST BE OFF WHILE CONNECTING THE SLAVE CABLE.

- Turn on the master switch in the receiving vehicle.

- Start the dead engine; adjust engine idling speed to slow idle.

- Disconnect extension cable from both vehicles as soon as the receiving vehicle idles at 650 RPM without stalling.

- Increase engine speed in receiving vehicle to 1,000 to 1,200 RPM. Check battery-generator indicator in the vehicle to make sure it shows that the battery is being charged.

TOWING TO START ENGINE

Attempting to start a vehicle by towing is ill-advised. Applying external power does not solve the problem of internal resistance due to frozen parts (i.e., lack of lubrication or hydrostatically locked engine). However, if all other expedients have failed and the following conditions are met, a vehicle with a manual transmission may be towed to start the engine:

- If the engine can rotate through one complete cycle, this shows that the engine is not hydrostatically locked.

- Lubricants are fluid enough to allow the engine to turn over without excessive drag.

- Lubricants in the transmission and transfer case permit gears to shift and allow operation without excessive drag on the power train.

- Lubricants in the wheel bearings and differential are not congealed. Check for wheel rotation by slowly towing the vehicle in neutral and ensuring all wheels are rotating. If towing the disabled vehicle on packed snow or ice, the wheels may slide. Try to find a dry or graveled surface; otherwise, if the wheels still refuse to rotate, warm the differentials with a swingfire heater or with the heat ducts of a portable heater; or if possible, move the vehicle slowly into a heated shelter and allow it to warm up.

- The hand brake is released, and neither the hand brake nor service brake linings are frozen to the brake drums.

CAUTION
TOWING A VEHICLE TO START ITS ENGINE WILL ONLY BE DONE IN AN EXTREME EMERGENCY. USE A TOW BAR WHEN TOWING. USE TOW CHAINS ONLY AS A LAST RESORT. THE OPERATOR'S MANUAL MUST BE CHECKED PRIOR TO TOW-STARTING ANY VEHICLE.. SOME VEHICLES CANNOT BE STARTED BY TOWING; IF ATTEMPTS ARE MADE TO TOW-START SOME EQUIPMENT, SEVERE TRANSMISSION DAMAGE MAY RESULT.

CAUTION
VEHICLES SHOULD NEVER BE STARTED BY PUSHING.

Section II
Chassis and Body Components

OPERATIONAL CONSIDERATIONS

Ice, mud, and snow build up to such an extent on operating vehicles that they overload vehicle components, reduce ground and other clearances, and prevent or interfere with normal operation of moving components. Buildup and freezing of slush and water around the wheels of an operating vehicle can cause a loss of steering ability.

Tracks

Check oil-lubricated road wheel bearings to ensure that water has not collected during operation. If significant amounts of water have collected, seals may rupture as the water freezes and expands. If possible, avoid quick starts, stops, sharp turns, and side slippage on ice and snow, as they can throw tracks and/or cause loss of control.

Tires

Tire pressure rises and falls with the temperature. Monitor tire pressure frequently to avoid flat tires or over-inflation. If tires have a flat spot where contact with the ground was made, use a light pressure on the accelerator and drive the vehicle slowly until generated heat permits tires to round out. Also, move vehicle often during periods of freezing rain or sleet. To prevent tires from freezing to the surface, place small branches or other insulating material under them before parking (Figure 3-2). If tires do freeze in place, use a portable hot air heater to unfreeze them.

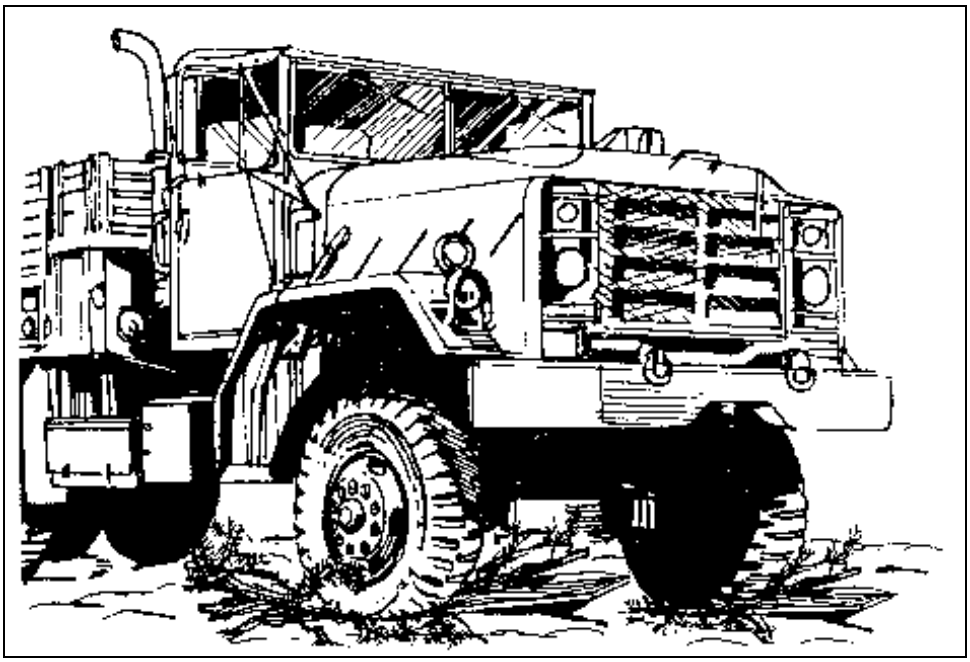


Figure 3-2. Place material under tires to prevent freezing

Tire Selection

Three types of nondirectional tires are available for use on standard tactical vehicles. They are the cross-country tire, the mud and snow tire, and the radial tire (as on the HMMWV). It is best not to mix tires on a vehicle. However, if tire stocks are depleted, different types may be used as long as only one type is used on any one axle. Some commercial vehicles in the Army inventory use commercial all-terrain radial tires. Early model HMMWV bias ply run flat tires mount on special rims. Later version radial tires are designed to run on newer style rims. These tire/wheel combinations should not be mixed on specific vehicles.

Chains

Check vehicle chains prior to operation to ensure that they are serviceable. Drivers should practice mounting and removing chains. Remove the chains when not needed; this practice keeps them in good condition. Chains wear out in approximately 350 miles of asphalt road operation. Also, they can damage vehicle and body suspension components.

Springs

When starting out, proceed with caution to allow springs time to attain flexibility. Avoid driving into depressions or over obstacles; this practice may create shocks that could break springs in extreme cold.

Cab Enclosures

Use heaters to maintain adequate temperatures within cab enclosures. When crossing frozen streams or other bodies of water, open cab doors to permit quick escape of personnel in case vehicle should break through the ice.

Note: Do not cross deep water obstacles covered with ice without checking with supporting engineer units for safe crossing ice thickness.

Parking Brakes

Do not park with brakes set; they may freeze in this position and not release. Use chock blocks to hold wheels or tracks in place. If brake components do freeze in the set position, use an external heat source (such as the portable duct heater) for thawing to prevent damage to the vehicle power train. For the small unit support vehicle (SUSV), parking brakes must be applied when stopped, since there is no neutral-park gear.

Section III
Power Train

OPERATIONAL CONSIDERATIONS

In severe conditions, specific procedures must be followed to safeguard a vehicle's power train. Following these procedures will ensure smooth operations.

Starting Conventional Transmissions

To start a conventional transmission, depress the clutch pedal while starting engine with gear shift in neutral. Once the engine is running smoothly, release the clutch cautiously; maintain the engine at idle for two minutes or longer to warm lubricant in the transmission.

NOTE: If vehicle is equipped with a transfer having a selector lever, transfer lubricant may be heated the same way by placing selector level in neutral and transmission in low.

Starting Automatic Transmissions

Automatic transmissions warm up differently, depending on the type. Some warm up in park, while others only warm up if the selector lever is in the neutral position; still others must be placed in gear during warmup. In extreme cold (-25°F and below), many transmissions will not warm up unless placed in gear, allowing the torque converter to pump and preheat the transmission fluid. Forced movement of the vehicle prior to warmup can cause transmission failure. Always consult the operator manual for proper transmission warmup procedures.

Idling

To idle the vehicle, adjust the hand throttle to the engine speed specified in the operator TM until the engine is running smoothly. Engage the engine clutch (where applicable) to allow gear case lubricants to warm. With transfer case levers remaining in the out position to prevent movement of the vehicle, depress the clutch and operate the transmission gear shift lever until the lever moves freely.

During Operation

The driver must be extremely careful when placing the vehicle in motion when gear case lubricants or wheel bearing greases are congealed and tires are frozen to the ground. Trying to operate under these conditions damages power train components, such as clutch facings, universal joints, or gear teeth. When placing the vehicle in motion, put transmission in low gear and transfer unit in low range. Drive the vehicle about 100 meters, being careful not to stall the engine, then upshift. Continue slowly in the higher gears until the vehicle moves freely and tire thump ceases.

After Operation

When preparing a vehicle for shutdown, place transmission and transfer shift levers in the neutral position. This prepares the vehicle for the next start by preventing the levers from freezing in an engaged position.

Section IV
Engine Lubrication System

OPERATIONAL CONSIDERATIONS

The mechanical efficiency of an engine depends on the proper functioning of the lubrication system. Careful attention to PMCS by the driver and unit mechanic is required to keep the system in the best working condition.

Check engine oil prior to starting and fill to prescribed level. As soon as the engine starts, check the reading on the oil pressure gauge. If engine oil pressure is not indicated within 30 seconds after starting, shut down the engine and determine the cause. On vehicles equipped with warning lights, stop the engine and investigate the cause (if the engine-oil pressure warning light does not go out within 30 seconds).

Engine temperatures ranging from 160° to 180°F must be maintained for normal operation. This temperature can be attained by adjusting the air inlet shutters or covers and by having a serviceable thermostat.

The oil pressure gauge and/or warning light must be observed frequently during operation because of increased equipment failures in extreme cold. Consult the operator manual for normal oil pressure. Report to maintenance personnel if normal operating oil pressure cannot be maintained. Low oil pressure warning lights may blink on and off at 500 to 650 RPM using OEA lubricant at idle, but they should not stay on at higher RPMs.

After each operating period, carefully inspect and service the system as follows:

- Inspect oil pan, valve covers, gaskets, and any external units of the lubrication system for leaks; correct deficiencies or report them to maintenance mechanics. During periods of extreme cold, it is not uncommon to observe leaks from various seals on hydraulic systems and oil filled components upon start-up. After the component reaches normal operating temperature and the seal becomes soft and flexible, these leaks should stop. Reporting leaking components before allowing sufficient time for the seal to warm up causes an undue burden on the maintenance system and unnecessary seal replacement.

- Check engine oil and fill to prescribed level.

CAUTION
OIL CONSUMPTION IS MUCH HIGHER WHEN USING OEA. ENGINES MAY RUN OUT OF OIL BEFORE THE NEXT MAINTENANCE CHECK. CHECK FREQUENTLY.

- At the end of each operating period, and five minutes prior to shutdown, normalize the vehicle engine to allow a coating of cooled oil to be retained on the cylinder walls and pistons. This prevents damage at the time of restarting. It can be accomplished by lowering the engine RPM to the prescribed high idling speed (see TM) and by maintaining it for about five minutes. This procedure is extremely important to preventing engine damage and is mandatory for all heavy-duty gasoline, multifuel, and diesel engines.

MAINTENANCE

The two most common failures of the engine lubrication system are caused by low or no oil pressure and the accumulation of sludge in the lubricating oil.

Low or No Oil Pressure

Low oil pressure is normally caused by fuel-diluted oil, hot oil, or low viscosity oil. No oil pressure may be caused by cold, congealed, high viscosity oil; a clogged

strainer; a defective oil pump; the lack of lubricant; or engine component failure (such as an engine bearing).

Note: Do not overlook the possibility that the oil pressure gauge may be defective. If the gauge is working correctly, the oil is up to the full mark, and the oil filter element is not clogged, the failure is probably in the pump or line.

Accumulation of Sludge in Lubricating Oil

Cold weather tends to prevent engines from reaching normal operating temperatures, increases the development of carbon in the engine, and increases oil dilution and condensation. These factors combine to create engine sludge (Figure 3-3). To correct a sludge condition, drain oil while engine is hot and refill with OEA.

After operation, inspect the oil pan, valve cover, timing gear cover and gaskets, and external oil lines for oil leaks; correct as necessary. To protect the environment, drip pans must be placed under all leaks. Turn in all used oil IAW host nation, federal, state, and local environmental laws and regulations and unit SOPs.

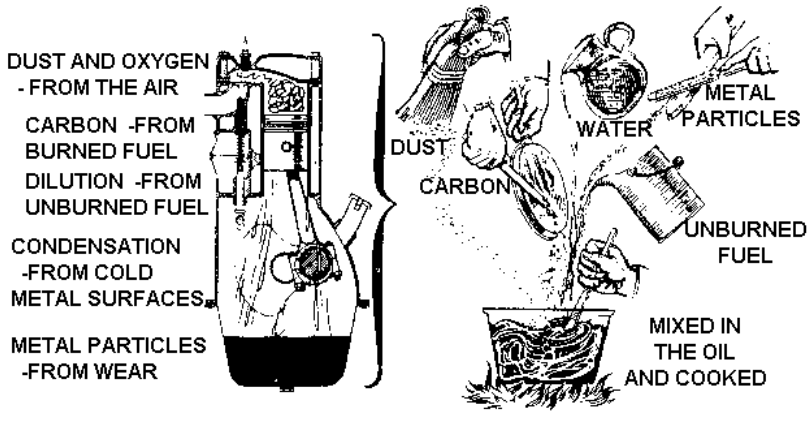


Figure 3-3. Engine sludge

Section V
Electrical System

STARTING PROCEDURES

The storage battery functions as the heart of the electrical system, especially during the starting phase. Pay particular attention to the battery terminals and clamps during cold weather. A loose connection or a small amount of corrosion will add a lot of resistance flow. The current drop that would not even be noticed during warm weather can keep the starter from turning over when the engine is cold-soaked. Also, loose connections and dirty terminals prevent the battery from receiving a full charge when it needs it most. When starting the engine, follow cold-start procedures in the TM, modified as needed by procedures outlined in Section I of this chapter.

If the engine fails to start, discontinue starter operation and turn off all switches being used to start the engine. Wait a few minutes for the starter to cool before attempting another start; repeat the process.

DURING OPERATION

During vehicle operation, adhere to the following guidelines:

- Allow the engine to warm up to the recommended temperature for sub-zero operation (thermostat opens at 180°F).

- Check operation of instruments during warmup, especially the oil pressure gauges and warning lights.

- Take advantage of all methods available to keep the battery at recommended temperature. If the battery is warm enough to accept a charge (above 35°F), the battery generator indicator should read in the high green immediately after starting.

- Note any unusual noise from the alternator. Fan belts break at a high rate below -50°F. Inspect belts for cracks prior to cold weather operation; replace cracked belts. Adjustable length belts are available for emergency roadside repair of "V" belts. They come in 3/8-, 1/2-, and 3/4-inch widths and require a connector tool to fit to size. Stock numbers are shown in Appendix C. Vehicles such as the HMMWV are equipped with serpentine belts, and only another serpertine belt can be used.

- Note any unusual noise from the generator.

MAINTENANCE

Emphasis must be placed on the proper care of electrical systems to ensure efficient operation.

If it is necessary to recharge a storage battery under low-temperature conditions (electrolyte not frozen), the charging voltage should be low enough to prevent excessive gassing or boiling of the electrolyte. At low temperatures, the permissible charging current is much less than at higher temperatures and, therefore, requires a proportionately longer charging time (see TM 9-6140-200-14).

WARNING
WATER SHOULD NEVER BE ADDED TO A COLD BATTERY; ADD IT WHEN THE BATTERY IS WARM AND CHARGING, OR IT WILL NOT MIX. FREEZING COULD RESULT DUE TO REDUCED SPECIFIC GRAVITY.

If water is added to a battery that is exposed to sub-zero temperatures and is being charged, the layer of water will stay at the top and freeze before it has a chance to mix with the electrolyte. Never attempt to recharge a battery with frozen electrolyte.

Never add water or electrolyte to a frozen or cold-soaked battery, an explosion may result.

NOTE: If adding water to a battery at temperatures of 32°F to approximately 50°F, do not fill to level indicated on cell cover or vent plug, since the electrolyte will expand as it is heated and the battery will flood. Acid or electrolyte should never be added to a battery once initiated into service. Use only distilled water.

Section VI
Fuel System

FUEL STORAGE

Successful operation of vehicles at low temperatures depends greatly on the condition of the fuels used. Water in engine fuel can cause serious difficulties. Trouble occurs in some engines even at temperatures above the freezing point of water. When air is drawn through a carburetor, the pressure is lowered and the fuel is sprayed or atomized by venturi action. The reduced pressure in the venturi and vaporization of fuel causes a refrigerating action that may lower temperatures enough to freeze water or vapor in the fuel.

The ice builds around the jet until the fuel supply to the combustion chamber is cut off, and the engine ceases to operate. Water settles to the bottom of fuel tanks and into the lowest parts of the fuel line; if it freezes, fuel cannot reach the carburetor or fuel injectors. As a result, the engine cannot be started. Moisture contamination of fuels is the source of many difficulties. Moisture can be the result of snow getting into the fuel, condensation due to breathing of a partially filled container when taken outdoors from a warmer temperature, or from fuel consumption during normal operation. Dry gas additives can be used if water has contaminated the fuel tank from condensation. To prevent contamination, the following precautions must be observed:

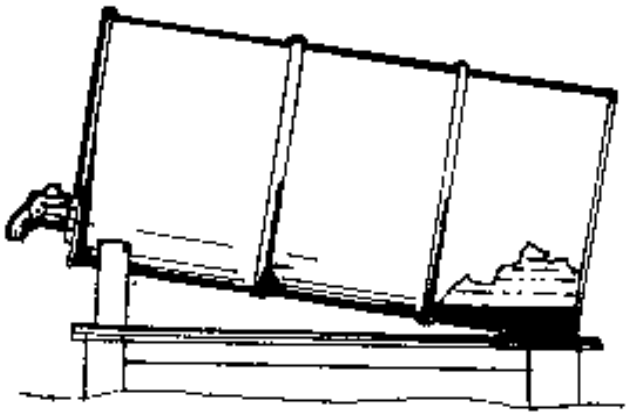
- Store barrels with outlet end slightly higher than the other end to allow sediment and water to settle out (Figure 3-4). Upright storage of barrels should be avoided to keep water and snow from accumulating. The last few gallons that remain in the barrel should be dumped into collecting barrels where foreign accumulation can settle and the usable fuel can be salvaged. Make sure all containers are thoroughly clean and rust-free before storing fuel in them. When barrels are stored, they must have secondary containment to prevent spillage to the ground.

- Wipe all snow or ice from dispensing equipment and around fill cap of fuel tank before removing cap. After filling tank, replace cap securely.

- Keep the fuel tank filled to proper markings at all times. Refuel only to the expansion marking immediately after halting to reduce condensation in the fuel tank. The more fuel there is in the tank, the smaller the volume of air from which moisture can be condensed.

WARNING

FUEL FLOWING OVER A SURFACE GENERATES STATIC, WHICH CAN CAUSE A SPARK UNLESS MEANS ARE PROVIDED TO GROUND THE ELECTRICITY. A METALLIC CONTACT BETWEEN THE DISPENSING TANK AND THE CONTAINER BEING FILLED MUST BE PROVIDED TO ENSURE AN EFFECTIVE GROUND. THIS HAZARD IS PARTICULARLY GREAT IN COLD, DRY AIR.



Note: Secondary containment must be used under barrels to prevent spillage to ground.

Figure 3-4. POL barrel storage

The carburetor air intake must be protected from chilling winds in sub-zero temperatures. Hood, radiator, and louver covers are either provided in winterization kits or can be easily manufactured and applied. Properly installed, the covers keep out cold winds and materially aid in attaining and maintaining adequately heated engine compartments.

MAINTENANCE

Satisfactory cold weather performance of fuel-related systems depends on careful servicing. Proper maintenance by unit mechanics precludes many malfunctions and failures that would otherwise occur in sub-zero temperatures. Maintenance should include the following:

- The throttle controls may operate with difficulty at low temperatures. If the engine does not respond properly to operation of controls, check for loose or broken controls, and for loose or broken control linkage or cable. Adjust linkage or replace defective parts as required IAW applicable TM. Clean wires with environmentally safe cleaning solvents and thoroughly dry them. Newer fuel injected systems are computer-controlled electronically, with no mechanical links to control throttle speed. These new systems are found on the PLS, FMTV, the new HET, and other tactical and combat vehicles. Operators must become thoroughly familiar with the cold weather starting procedures for these vehicles. For example, when starting and operating these vehicles, there is little or no throttle response until the engine temperature sensors send information to the computer that the engine is warm enough to operate. Other steps are also required, such as the use of an exhaust restrictor for the FMTV when starting in extreme cold.

- Inspect fuel filters for good condition and replace contaminated elements. Dispose of unserviceable fuel filters in an environmentally safe manner as outlined in the unit SOP. Clean the metal disc type filters with dry-cleaning solvent, dry, and install. Make sure there are no leaks.

- Drain fuel filters at the end of each day of operation. Do not assume that filters are dry if nothing flows from the drain cock. If water is present, it could have frozen solid

overnight. Drain filters into an approved and appropriately marked and labeled container and turn in IAW unit SOPs for disposal.

- Check the diesel-fuel injection pump, including transfer pump, to ensure that it is in good condition, correctly assembled, and securely mounted, and that connections are not leaking.

- Check diesel-fuel nozzles and lines to ensure good condition.

- Check whether fuel gauge is operating and registering amount of fuel in the tank.

- Ensure filters are drained into a container and disposed of properly according to unit SOP. Identify any special HN disposal requirements in advance.

Section VII
Cooling System

STARTING CONSIDERATIONS

Most winterization kits for starting below -25°F include a fuel-fired engine coolant heater such as the swingfire. It is very important to understand the operating instructions before use. Failure to turn on or ensure the auxiliary water circulation pump is running will most likely cause coolant hoses to burst. When the engine is operating, observe the temperature gauge to ensure that the temperature rises gradually. A sudden rise in temperature indicates either a frozen radiator, insufficient coolant, or an inoperative thermostat. Stop the engine immediately and determine cause.

MAINTENANCE

Cooling systems must be carefully maintained to ensure normal engine operating temperatures. Temperatures must be observed throughout vehicle operations.

Operating Temperature

Operate vehicles at normal engine temperatures as indicated in operator's TM (Figure 3-5). Temperatures can be maintained by properly adjusting the engine compartment air inlet shutters or radiator covers. Low engine operating temperature results in excessive fuel consumption, dilution of engine oil by unburned fuel, and formation of sludge from condensation of water in cylinders and crankcase.

CAUTION

AN ENGINE THAT FAILS TO REACH NORMAL OPERATING TEMPERATURE OR OVERHEATS MUST BE REPORTED TO MAINTENANCE PERSONNEL FOR CORRECTION. FAILURE TO DO SO MAY RESULT IN SERIOUS DAMAGE TO THE ENGINE.

After Operation

The radiator should be checked after shutdown to determine coolant level. If the coolant level is low, add antifreeze to return radiator to full level.

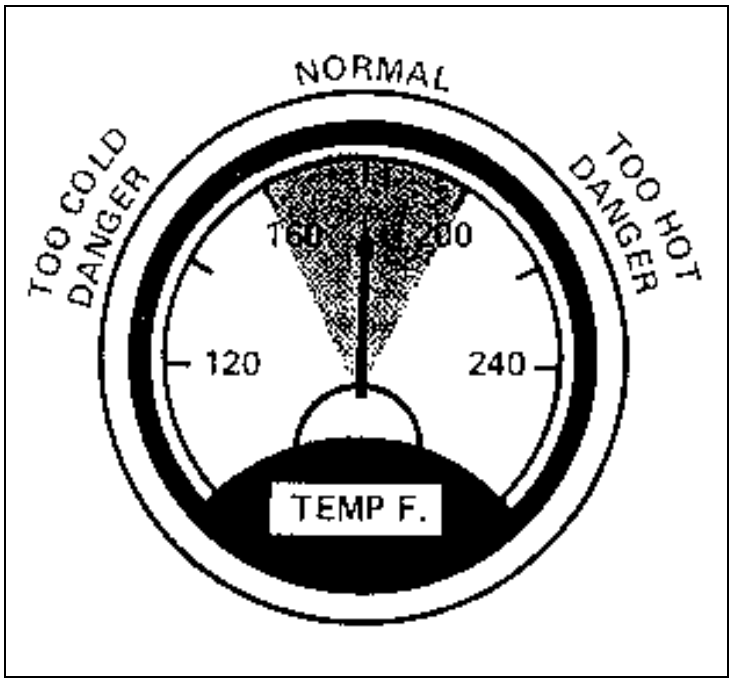


Figure 3-5. Normal operating temperature

Section VIII
Auxiliary Equipment

OPERATIONAL CONSIDERATIONS

Auxiliary equipment cannot be overlooked in preparing for cold weather operations. Failure of these items can also lead to mission failure.

Air Compressors

The vehicle air compressor requires little attention for cold weather operation. Soldiers must check to see if the compressor is maintaining required pressure and that there are no coolant or oil leaks or excessive noise.

Maintenance Steps

To ensure air compressors function properly, operators must:

- Examine air compressor to ensure that it is in good condition, properly aligned with drive pulleys, and securely mounted. Equipment using air dryers must also be checked for frozen vapors in the drip tube.

- Ensure that all water, oil, and air lines in the engine compartment are in good condition and securely fastened, and that there are no leaks.

- Check oil in self-lubricated air compressors to determine proper condition and level.

- Check alcohol evaporators, as indicated in Chapter 2 of this manual.

POWER TAKEOFF ASSEMBLIES

The power takeoff and control linkage should be checked to ensure they are in good condition, securely mounted, and that seals are not leaking. Ensure that the proper sub-zero lubricant is used and maintained at the proper level. See that the transmission and/or breather and ventilation openings and lines are clear. Tighten all mounting bolts, power

takeoff assembly screws, and bolts to the torque tightness specified in the TM.